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Review Article

Case presentation and short perspective on management of foraminal/far lateral discs and stenosis

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Abstract

Background: The management of lumbar foraminal/far lateral discs (FOR/FLD) with stenosis remains controversial. Operative choices should be based on each patient's preoperative dynamic X-ray findings, magnetic resonance (MR), and computed tomography (CT) studies. Here we reviewed several options for decompression alone vs. decompression with fusion.

Methods: Safe excision of FOR/FLD with stenosis should begin at the level above the disc herniation, as identification of the superior, foraminally, and far laterally exiting nerve root is critical. Performing an undercutting laminectomy and utilizing an operating microscope usually preserves the facet joints, and in many cases, avoids the need for fusion. Other decompressive techniques include; the intertransverse (ITT), and Wiltse approaches. Fusions following complete unilateral full facetectomy may be; noninstrumented (e.g., older, osteoporotic patients) vs. instrumented (e.g., posterolateral fusion or occasionally transforaminal lumbar interbody fusion). Here we present a patient with L2-L5 stenosis, and a left L3-L4 FOR/FLD, and multiple synovial cysts who was successfully managed with an l2-L5 laminecotmy, left L34 FOR/FLD diksectomy without fusion.

Results: Postoperatively, the patient was neurologically intact, and stability was maintained. Adjunctive measures for FOR/FLD diksectomy should include; intraoperative monitoring, use of the operating microscope, and an intraoperative film with a radiopaque marker in the correct disc space to confirm the correct level of diskectomy.

Conclusions: There are multiple approaches to the excision of FOR/FLD with stenosis. These include; decompression alone vs. decompression with non-instrumented vs. instrumented fusion. Surgical choices must be based on individual patient's X-ray, MR, and CT findings. The aim should be to maximize the safety of disc excision with decompression of stenosis, and to preserve stability, reducing the need for fusion, while minimizing morbidity.

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Key Words: Decompression, facet excision, far lateral disc, foraminal, fusion, intertransverse technique, instrumented fusion, intraoperative monitoring, lumbar, microscope, Wiltse approach, X-ray control

INTRODUCTION

There are many techniques available for treating lumbar foraminal/far lateral disc (FOR/FLD) herniations with stenosis. The choice of surgical procedures must be based on each patient's preoperative dynamic X-ray, MR, and CT findings. Decompressive procedures may vary, and can include; laminotomy/laminectomy alone, the intertransverse approach (ITT), and Wiltse's far lateral technique. Where full unilateral facetectomy is warranted, patients may require noninstrumented vs. instrumented fusions (e.g., pedicle screws with posterolateral lumbar fusion (PLF), or rarely, transforaminal lumbar interbody fusion (TLIF)). No matter what operative approach is chose, adjunctive measures should include; continuous intraoperative physiological monitoring (e.g., somatosensory evoked potentials and electromyography), the use of an operating microscope, and an intraoperative radiograph with a marker within the disc space to confirm the correct level of disc removal.

MATERIALS AND METHODS

Symptoms and signs of foraminal/far lateral discs

The symptoms and signs for patients with lumbar FOR/FLD vary.[2-6] As these discs typically directly compress the dorsal root ganglion (DRG) of the superior/foraminally/far laterally exiting nerve root (e.g. within the axilla), these patients typically exhibit a superior unilateral radiculopathy. For example, at the L4-L5 level, the patient may demonstrate a predominant L4 root syndrome. Additional pathology may include; stenosis, ossification of the yellow ligament (OYL), and synovial cysts. These degenerative changes may further contribute to thecal sac and inferior L5 root compression at the index level (e.g., L4-L5).

Evaluation of FOR/FLD with dynamic X-rays, MR, and CT studies

Dynamic X-rays, MR, and CT studies contribute to the correct diagnosis, localization, and management of lumbar FOR/FLD and attendant stenosis.[2-6] Dynamic X-rays document whether there is active motion at the level of the FOR/FLD. If there is instability, additional noninstrumented vs. instrumented fusion may be warranted. On axial MR studies, typically localized to the disc spaces, FOR/FLD extending to the mid-vertebral level may be under diagnosed or missed. Here, careful evaluation of the parasagittal MR images may better demonstrate FOR/FLD extension (e.g. laterally/foraminally, and inferiorly). However, CT studies, with contiguous axial 2 mm cuts, may more readily pick up the full extent of FOR/FLD, while also documenting the presence of accompanying limbus vertebral fractures. Further, MR and CT studies combined should better confirm the extent of stenosis, OYL, and/or the presence of accompanying synovial cysts.

History of decompressive surgery for lumbar FOR/FLD

FLD: Wiltse far lateral approach to lumbar FLD

Wiltse and Spencer in 1988 described a purely far lateral approach to lumbar disc herniations [Table 1].[10] This procedure involved dissection/exposure focused lateral to the canal, and the facet joint. The Wiltse procedure became known for: "Specifically, its use for removing a far lateral disc, decompressing a far out syndrome, (and) inserting pedicle screws…" In some cases, it also required resection of the lateral one-third of the facet joint to attain more extensive exposure of the lateral foramen. Taking down the intertransverse ligament and fascia, the Wiltse approach offered far lateral exposure of the cephalad/foraminally/far laterally exiting nerve root, but no access to the medial spinal canal and/or proximal or mid portion of the neural foramen. Therefore, in the presence of significant stenosis or other spondyloarthrotic pathology within the spinal canal and proximal/mid foramen, this approach will typically not suffice.

Decompressions for 170 Lumbar FOR/FLD

In 1995, Epstein initially evaluated the surgical procedure/outcomes for 170 MR/CT confirmed FOR/FLD (1984–1994) [Table 1].[2] These patients were managed with three different decompressive operative approaches: complete facetectomy (n = 73), laminotomy with medial facetectomy (n = 39 patients), and intertransverse discectomy (ITT: Intertransverse Approach) (n = 58 patients). Patients were followed on an average of 5 years. Of interest, outcomes were comparable for all three groups; good/excellent results were obtained in 79% intertransverse approach (ITT), 70% facetectomy group vs. 68% laminectomy/laminotomy. Therefore, the optimal lumbar FOR/FLD decompressive procedure should offer the best exposure for that specific patient, irrespective of the need for more extensive facet resection. Of interest, outcomes across all groups were comparable with very rare requirements for fusion.

SF-36 outcome study for FOR/FLD lumbar discs

In 1997, Epstein and Hood utilized the Medical Outcome Trust's SF-36 Short Form to assess outcomes for 76 (45% of the original sample of 170 patients) patients undergoing the three different operative

Table 1: Summary of approaches to lumbar for/FLD herniations

Author [Ref] year	Number of patients surgery for/FLD	Data	Data	Data	Data/Complications
Wiltse[10] 1988	Wiltse paraspinal	Far lateral lumbar discs	NA	NA	NA
Epstein[2] 1995	170 FOR/FLD followed avg. 5 years	FAC N=73 LAM N=39 1984-1994	ITT N=58 3 groups same outcomes	MacNab's criteria:	Excellent/good 79% ITT 70% FAC 68% LAM
Epstein and Hood[3] 1997	SF-36 outcomes trust data 1984-1994	76 FOR FLD (45% Responded)	Followed 9.1 mos. 2.8 years	73 FAC 39 LAM 58 ITT (45%)	MacNab's Excellent/good (32/24), fair (12), poor (8) All results comparable
Sasani[8] 2007	MI PERC MI ED for FOR/FLD 66 patients	1998-2005 Followed 6-12 mos.	42 L4-L5 19 L3-L4 5 L2-L3	COMP 2-No access 2 Rec Disc 4 root deficit	REOP 9 (13.6%) of 66 FOR FLD
Liu[7] 2012	3 MI to 52 FLD	2000-2006 Followed Avg. 13.5 mos.	25 MI ED 13 METRx 14 X-Tube diskectomy	Similar outcomes all groups	Excellent outcomes 84%, 84.6%, 92.8% Comparable VAS scores
Celikoglu[1] 2014	33 FLD ITT	2006-2011	12 L3-L4 15 L4-L5	MacNab's outcomes: 4 Fair	MacNab's outcomes 29 Excellent/good
Wang[9] 2016	MI TLIF for FLD 539	5 Reop 1 FLD out of 34 FLD	5 Reop 1 recurrent disc 3 DS	Comp 5 or 539 Reop	Reop - DRG/POD 1 of 34 FLD
Epstein[6] 2017	2-3 Level Lam (n=58) 4-6 Level Lam (n=79) followed 2 years	2-3 Level Lam (n=58) 20 Synovial cysts 1 DS 48 HNP (12 FLD)	4-5 Level Lam (n=79) 36 synovial cysts 26 DS 39 Discs (16 FLD)	1 Reop Seroma (7 days postop)	0% fusions 0% neurodeficits 0% readmissions 0% infections
Epstein[5] 2017	59 LAM (Avg. 4 levels) *In situ* fusion (Avg. 1.2 levels)	Nanoss BMA Lamina autograft Followed Avg. 1.3 years	51 DS 2 Lysis 32 synovial cysts 21 Discs (10 FOR/FLD)	97% Fusion CT/XR Avg. 4.9 mos. Postop	COMP 2 pseudarthrosis asymptomatic (comorbidities: osteoporosis, morbid obesity, smokers)

Lam: Laminectomy, ITT: Intertransverse approach, Avg.: Average, FAC: Facetectomy, DRG: Dorsal root ganglion, POD: Postoperative paresthesias, DS: Degenerative spondylolisthesis, OYL: Ossified yellow ligament, Syn: Synovial cyst, BMA: Bone marrow aspirate, FOR/FLD: Foraminal/far lateral disc: SF-36: Short-form 36 outcomes trust data, PERC: Percutaneous, ED: Endoscopic diskectomy, COMP: Complications, Reop: Reoperations, Rec: Recurrent, Neuro: Neurological

approaches enumerated above for lumbar FOR/FLD (1984 and 1994) [Table 1].[3] Patients averaged 60.1 years of age. SF-36 evaluations were obtained an average of 9.1 months (direct assessment), and 2.8 years postoperatively (phone interviews). Outcomes were excellent (n = 32), good (n = 24), fair (n = 12), and poor (n = 8). As outcomes were comparable for all three procedures, this patient-based outcome study confirmed that the decompression chosen for any patient with a lumbar FOR/FLD should best be tailored to their specific requirements, irrespective of the extent of facet resection.

2007: Minimally invasive endoscopic discectomy/FOR/FLD; increased morbidity

In 2007, Sasani *et al*. evaluated the safety/efficacy of percutaneous minimally invasive (MI) endoscopic discectomy for FOR/FLD in 66 patients (1998–2005) [Table 1].[8] They determined from the literature that FOR/FLD constituted 11% of all lumbar disc herniations. Discs were respectively located at: L4-5 (n = 42; 64%), L3-4 (n = 19, 28%), and the L2-3 levels (n = 5, 8%). Patients were followed for 6–12 postoperative months. There were nine complications. For two patients (n = 1, L4-5 and n = 1, L4), the FLD could not be accessed using this technique; rather, diskectomy with microscopic visualization was required (e.g. secondary surgery). Three (n = 3, L4-5) patients required additional operations 3-6 months later. Furthermore, 2 patients (n = 2, L4-5) sustained partial nerve root injuries attributed to operative dissection, and another 2 patients (n = 2, L4-5) sustained neural injuries due to malpositioning of the working channel itself. At six postoperative months, the authors found all patients had improved, but voiced the following concerns: "Percutaneous endoscopic discectomy is a minimally invasive method and offers many benefits to the patient, but extensive surgical practice is needed to become a capable surgeon." Notably, the total morbidity for this MI endoscopic approach was 13.6% (9 patients) of the 66 cases. These data should prompt one to ask whether the time has *not* come for MI endoscopic surgery for lumbar FOR/FLD.

2012: Three different minimally invasive decompressions for FOR/FLD

Liu *et al.* (2012) documented comparable results for three different MI procedures addressing 52 (2000–2006) FLD [Table 1].[7] They noted FLD comprised 2.6–11.7% of all lumbar disc herniations. Procedures included MI endoscopic discectomy (n = 25), METRx discectomy (n = 13), and X-tube discectomy (n = 14). Patients were followed or a mean of 13.5 months. Postoperatively, excellent outcomes were seen in 84.0, 84.6, and 92.8% patients respectively. Visual analog scale (VAS) scores were also comparable across all three groups. Note in this study, the number of patientsin each operative group was relatively small. Therefore, any conclusions regarding the safety of these minimally invasive procedure, based on this study, are of limited value.

2014: Extraforaminal intertransverse (ITT) approach to lumbar FLD (far lateral lumbar disc herniation)

In 2014, Celikoglu *et al.* evaluated the extraforaminal surgical management of 33 far lateral lumbar discs utilizing an intertransverse approach (ITT) (e.g. with median or paramedian incisions) (2006–2011) [Table 1].[1] Patients averaged 51.2 years of age, and had surgery at L3-4 (12 patients) or L4-5 (15 patients) utilizing median paramuscular (20 patients, 61%) or paramedian intermuscular (13 patients, 39%) approaches. With MacNab's criteria, the outcomes were graded as excellent/good (29), and fair/poor (n = 4). They concluded the ITT procedure for far lateral lumbar disc herniations was a safe and effective surgical alternative that avoided spinal instability. Furthermore, it was preferable to a laminectomy with medial or total facetectomy. Hypothetically, the ITT approach sounds ideal. However, it limits visualization and may increase the risk of injury to the mid-foraminal portion of the cephalad foraminally and far laterally exiting nerve root. Furthermore, it typically requires more extensive facet resection both medialy and far laterally, leaving the intervening facet weakened and subject to facture.

Efficacy of laminectomy alone for excision of FOR/FLDs

Over two postoperative years, Epstein (2017) observed low complication and reoperation rates for 58 patients undergoing 2-3 level and 79 patients undergoing 4-6 level lumbar laminectomies without fusions, including those with FOR/FLD [Table 1].[6] The 2-3 level procedures addressed; 20 synovial cysts, 1 degenerative spondylolistheesis (DS), and 48 herniated discs. Twelve of the 48 discs were FOR/FLD discs involving the L2-3 (n = 1), L3-4 (n = 1), L4-5 (n = 6), and L5-S1 (n = 4) levels. The 4-6 level operations additionally addressed; 35 synovial cysts, 26 with DS, and 39 lumbar discs. Sixteen of 39 were FOR/FLD discs located at the L2-3 (n = 1), L3-4 (n = 2), L4-5 (n = 10), L5-S1 (n = 3) levels. Of interest, no patient in either series developed a new neurological deficit. Furthermore, there were no infections, and none warranted readmission. Only one patient in the 4-6 level laminectomy group required secondary surgery (e.g., 7 days postoperatively for a seroma). Notably, atlhough a total of 28 (20.4%) of 137 patients with lumbar stenosis additionally had FOR/FLD, none developed postoperative lumbar instability requiring a fusion.

CASE REPORT

A patient with a history of low back pain, presented with 10 days of severe left lower extremity numbness, tingling, and weakness. The dynamic X-rays, MR, and CT studies demonstrated moderate stenosis/OYL L2-L5, bilateral synovial cysts at L4-L5, a left L3-L4 synovial cyst, and a massive left L3-L4 FOR/FLD with limbus fracture. The FOR/FLD disc herniation extended all the way to the L2-L3 level (e.g. markedly compressing the axilla of the L3 root) [Figures 1–4]. Surgery required an L2-L5 laminectomy, resection of bilateral L4-L5, and the left L3-L4 synovial cysts, plus resection of a massive left L3-L4 FOR/FLD with limbus fracture using the down-biting curette/mallet technique. Utilizing the operating microscope and the undercutting technique, allowed for preservation of the facet joints and stability. The operating microscope and intraoperative monitoring helped avoid neural injury. At surgery, an intraoperative lateral X-ray clearly documented a Penfield elevator

Figure 1: The axial T2-weighted MR scan obtained just above the L3-L4 level documented the foraminal and far lateral extent of the L3-L4 disc herniation (*arrow*), which migrated superiorly. Note the obliteration of the left-sided cephalad L3 root

Figure 2: The parasagittal T2 MR scan documented the massive left-sided foraminal, far lateral, disc fragment (*arrow*) originating at the L3-L4 level with substantial superior migration opposite the L3 pedicle

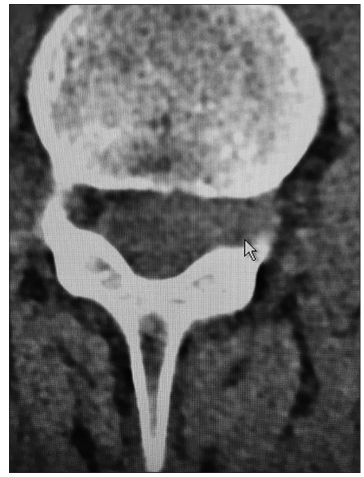

Figure 3: The soft tissue window axial CT obtained just above the L3-L4 disc level similarly documented the foraminal and far lateral extent of the L3-L4 disc herniation (*arrow*). Note the absence of significant ossification/spur formation

Figure 4: The left-sided parasagittal CT scan, compared with the MR, more poorly documented the massive foraminal, far lateral, disc fragment (*arrow*) originating at the L3-L4 level with substantial superior migration

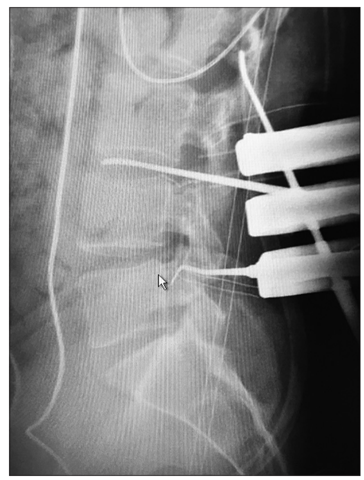

Figure 5: Penfield elevator in the L3-L4 disc space itself to confirm the correct localization. Note the Penfield/dental tool at the cephalad L2 and caudal L5 extent of the lumbar decompression

correctly located within the L3-L4 disc space (e.g. this is used to avoid wrong-level diskectomy) [Figure 5]. Postoperatively, the patient was neurologically intact, and never demonstrated instability.

Noninstrumented and instrumented fusion alternatives for lumbar FOR/FLD

Lumbar laminectomy with in situ fusion for stenosis and including FOR/FLD

In 2017, 59 patients underwent multilevel laminectomies (average 4.0 levels) and noninstrumented fusions (average 1.2 level) [Table 1].[5] Epstein documented high noninstrumented fusion rates utilizing lamina autograft and Nanoss (RTI Surgical Alachua, FL, and USA) combined with autogenous bone marrow aspirate [Table 1].[5] Prior to surgery, patients exhibited OYL/stenosis, DS (n = 51), spondylolysis (n = 2), synovial cysts (n = 32), and disc herniations (n = 21). Ten of the 21 discs were FOR/FLD: L2-3 (n = 1), L3-4 (n = 2), L4-5 (n = 6), L5-S1 (n = 1). Postoperatively, patients were followed an average of 3.1 years. The X-ray/CT studies documented a 97% postoperative fusion rate occurring an average of 4.9 months postoperatively (57 of 59 patients). Two patients with severe osteoporosis, morbid obesity, and smoking histories had pseudarthroses that were not sufficiently symptomatic to warrant additional surgery.

Decompression with instrumented fusion for far lateral lumbar discs

A unilateral full facetectomy may be required for excision of FOR/FLD, particularly when combined with severe spondyloarthrosis, DS, and/or spondylolisthesis/lysis. Here, a full facetectomy provides excellent visualization of the entire course of the cephalad, foraminally, and far laterally exiting nerve root along with the ipsilateral thecal sac and inferiorly exiting nerve root. In these cases, patients may require a posterolateral fusion (PLF) utilizing pedicle/screw instrumentation, or in select cases, a TLIF. Nevertheless, the addition of an interbody device may require increased manipulation of the thecal sac and/or nerve roots increasing perioperative morbidity (e.g., neruological root deficits, increased cerebrospinal fluid leak, etc.).

2016 Dorsal root ganglion (DRG) injury for MI TLIF for FLD

In 2016, Wang *et al.* observed that 5 (0.9%) of 539 patients exhibited postoperative dysesthesias (POD) attributed to DRG injury following MI TLIF (2010–2014) [Table 1].[9] One of these five cases involved a complication attributed to a FLD; in toto, this meant there was 1 (3%) complication out of a total 34 patients with FLD. Here, the exposure provided by the MI TLIF may not have afforded adequate visualization of the cephalad foraminally/far laterally exiting nerve root, making it more susceptible to injury. Of interest, the remaining four injuries were due to: 1 recurrent lumbar disc herniation (1/36 recurrent discs; 3%), and 3 instances of DS (3 out of 201 with DS; 1%).

DISCUSSION

There are multiple alternative operative approaches for the management of lumbar FOR/FLD with stenosis. Preoperative assessment requires dynamic X-rays, MR, and CT studies to document the full extent/location of the FOR/FLD and accompanying stenosis and other degenerative pathology. When performing a medial intracanalicular decompression, one should utilize the operative microscope and the undercutting technique to preserve the lateral 2/3 of the facet joint, and maintain stability. Further, the extent of facet resection should be minimized by utilizing the operative microscope. The use of intraoperative monitoring should help avoid neural injury. Performing any one of the various MI techniques (e.g., endoscopic discectomy or MI TLIF) may unnecessarily add morbidity (e.g., root injury, retained disc, residual stenosis). Finally, no matter what the operative approach, it is critical to obtain an intraoperative lateral radiograph with an instrument in the correct disc space to avoid wrong level surgery.

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Conflicts of interest

There are no conflicts of interest.

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